In re Appln. Of: Ed VanDyne et al.
Application No.: Not Yet Assigned

CLAIM LISTING

1. (Currently Amended) A method for controlling the level of exhaust gas recirculation (EGR) admitted into a combustion chamber of a reciprocating engine comprising the steps of:

evaluating an ionization signal;

comparing a real time average ion current signal to a target ion current wave form corresponding to a desired level of EGR; and

adjusting the level of EGR admitted into the combustion chamber based on the evaluation of the ionization signal and such that the real time average ion current signal is within a tolerance window of the target ion current wave form.

2. (Cancelled).

3. (Currently Amended) The method of claim 1 ~~2~~ wherein the step of adjusting the level of EGR admitted into the combustion chamber further includes adjusting the level of EGR admitted into the combustion chamber to a highest level such that the average real time ion current signal is at a minimum level where misfire does not occur.

4. (Original) The method of claim 3 wherein the step of adjusting the level of EGR to the highest level such that the average real time ion current signal is at the minimum level where misfire does not occur comprises the steps of:

increasing the level of EGR until an individual cycle ionization signal curve has an area at or below a threshold level;

defining a target level for the running average at the point that is one cycle before the individual cycle ionization signal curve with an area at or below the threshold level; and

lowering the level of EGR to the a level such that the average ionization curve for that engine condition stays proximate to the target level.

5. (Currently Amended) The method of claim 1 ~~2~~ further comprising the steps of:

lowering the target average ion current to increase the desired level of EGR; and

raising the target average ion current to decrease the desired level of EGR.

6. (Original) The method of claim 5 further comprising the step of determining a starting point of the average ionization current above a threshold level corresponding to the desired level of EGR and wherein the step of comparing an average ion current signal to the target average ion current comprises the step of comparing a starting point of the average ionization current to a desired starting point target for the rise of the average ionization current.

7. (Original) The method of claim 1 further comprising the step of measuring the ionization signal with a negative polarity of ionization on the electrode of an ion sensor.

8. (Currently Amended) The method of claim 1 ~~2~~ further comprising the steps of:

receiving a plurality of ion current signals over a plurality of engine combustion cycles; and

averaging the plurality of ion current signals to derive the real time average ion current.

9. (Original) The method of claim 8 wherein the step of receiving the plurality of ion current signals over a plurality of engine combustion cycles comprises the step of measuring the plurality of ion current signals over a set number of engine combustion cycles.

10. (Original) The method of claim 9 wherein the step of measuring the plurality of ion current signals comprises the step of measuring the plurality of ion current signals using a spark plug type of ion sensor.

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11. (Original) The method of claim 9 wherein the step of measuring the plurality of ion current signals comprises the step of measuring the plurality of ion current signals using an ion sensing apparatus integral with an ignition system.

12. (Original) The method of claim 1 wherein the ionization signal has a second peak corresponding to the peak temperature of the combustion process and the step of adjusting the level of EGR admitted into the combustion chamber based on the evaluation of the ionization signal comprises the steps of:

comparing a real time average of a crank shaft angle of the second peak of the ionization signal to a target angle of the second peak of the ionization signal corresponding to a desired level of EGR; and

adjusting the level of EGR admitted into the combustion chamber such that the real time average of the angle of the second peak of the ionization signal is within a tolerance window of the target angle.

13. (Original) The method of claim 12 wherein the step of adjusting the level of EGR admitted into the combustion chamber such that the real time average of the angle of the second peak of the ionization signal is within a tolerance window of the target angle comprises the steps of:

if the real time average of the crank shaft angle of the second peak of the ionization signal is advanced of the target angle, increasing the level of EGR until the real time average of the crank shaft angle of the second peak of the ionization signal is within a tolerance of the target angle; and

if the real time average of the crank shaft angle of the second peak of the ionization signal is retarded of the target angle, decreasing the level of EGR until the real time average of the crank shaft angle of the second peak of the ionization signal is within a tolerance of the target angle.

14-57. (Cancelled)

58. (Original) A method for controlling the level of exhaust gas recirculation (EGR) admitted into a combustion chamber of a reciprocating engine comprising the steps of:

comparing the real time average peak location of the ion current signal to a target angular peak location of an average ion current corresponding to a desired level of EGR; and

adjusting the level of EGR admitted into the combustion chamber such that the average peak location of the ion current signal is within a tolerance window of the target angular peak location.

59. (Original) The method of claim 58 further comprising the step of measuring the ionization current with a negative polarity of ionization on the electrode of an ion sensor.

60. (Original) A method for controlling the level of exhaust gas recirculation (EGR) admitted into a combustion chamber of a reciprocating engine comprising the steps of:

comparing a real time delta between the start of combustion and the average peak location of the ion current signal to a target angular delta between the start of combustion and the peak location of the average ion current that corresponds to a desired level of EGR; and

adjusting the level of EGR admitted into the combustion chamber such that the delta between the start of combustion and the average peak location of the ion current signal is within a tolerance window of the target angular delta.

61. (Original) The method of claim 60 further comprising the step of measuring the ionization current with a negative polarity of ionization on the electrode of an ion sensor.

62. (Original) A method for adjusting the rate of injection of exhaust gas recirculation (EGR) admitted into a combustion chamber of a reciprocating engine comprising the steps of:

comparing a real time delta between the start of combustion and the average peak location of the ion current signal to a target angular delta between the start of combustion and the peak location of the average ion current that corresponds to a desired level of EGR; and

adjusting the rate of injection of EGR admitted into the combustion chamber such that the delta between the start of combustion and the average peak location of the ion current signal is within a tolerance window of the target angular delta.

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63. (Original) The method of claim 62 further comprising the step of measuring the ionization current with a negative polarity of ionization on the electrode of an ion sensor.

64. (Original) A method for controlling the level of exhaust gas recirculation (EGR) admitted into a combustion chamber having two exhaust valves of a reciprocating engine comprising the steps of:

actuating a first exhaust valve of the two exhaust valves in a normal fashion; and

variably actuating a second exhaust valve of the two exhaust valves corresponding to a desired level of EGR.

65. (Original) The method of claim 64 wherein the step of variably actuating the second exhaust valve includes the step of opening the second exhaust valve for varying lengths of time during an intake stroke of the reciprocating engine.

66. (Original) The method of claim 65 wherein the step of opening the second exhaust valve for varying lengths of time during an intake stroke includes the step of opening the second exhaust valve for varying lengths of time based upon feedback from an ionization current signal in order to achieve the desired level of the level of EGR admitted into the combustion chamber.

67. (Original) The method of claim 66 further comprising the step of measuring the ionization current with a negative polarity of ionization on the electrode of an ion sensor.

68-87. (Cancelled)

88. (New) The method of claim 1 wherein the reciprocating engine is a diesel engine.

89. (New) The method of claim 1 wherein the reciprocating engine is a homogeneous charge compression ignition (HCCI) engine.